

# Publication and patent behavior of academic researchers: Conflicting, reinforcing or merely co-existing?

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## Abstract

Increasing entrepreneurial activity within academia has raised concerns that the number of publications added to the scientific commons might be reduced or that academic research would be directed exclusively towards the application-oriented needs of industry. In the case of academic inventions, the potential conflict between public- and private-oriented considerations seems most salient. In this contribution, we examine whether the publication behavior of academic inventors (at K.U. Leuven) differs from their colleagues (non-inventors) working within similar fields of research. Our analysis reveals that inventors publish significantly more. Moreover, no empirical evidence was found for the ‘skewing problem’. These findings not only suggest the co-existence of both activities; they may actually reinforce each other.

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## 1. Setting the stage: entrepreneurial universities

Science-industry relationships have received considerable attention over recent decades due to an increasing recognition of the fundamental role of knowledge and innovation in fostering economic growth, technological performance and international competitiveness. Different scholars have described and analyzed the multitude of interactions among different types of actors that play a role in the process of knowledge generation and diffusion (Freeman, 1987, 1994;

Lundvall, 1992; Nelson, 1993; Nelson and Rosenberg, 1993; Mowery and Nelson, 1999; Dosi, 2000). In this context, the concept of the ‘innovation system’ has been advanced as a general framework for designing innovation policies and adequate supportive institutional arrangements (OECD, 1999; European Innovation Scoreboard, 2002). Knowledge-generating institutions, like universities and research laboratories, industrial public and private research laboratories (the dominant loci of R&D and innovation in most fields) and more recently, government agencies, are seen as key actors in stimulating and influencing the innovative potential of any society (Van Looy et al., 2003). This renewed interest resulted in new insights into university–industry interactions during the 1990s (Dasgupta and David, 1994) based on the concepts of (1) scientific networks (Steinmueller,

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1994; David et al., 1997; Pavitt, 1997), (2) strategy and its concomitant structural analysis of industries and competitors (Porter, 1995), (3) evolutionary economic thinking (Nelson, 1995) and (4) a new vision for industry, academia and government interactions as encompassed by the ‘Triple Helix’ model (Etzkowitz and Leydesdorff, 1997, 1998; Leydesdorff and Etzkowitz, 1996, 1998).

Along similar lines, the concept of ‘entrepreneurial universities’ (Branscomb et al., 1999; Etzkowitz, 1998; Etzkowitz et al., 1998) has increasingly been used in relation to the spectrum of developments that have taken place in recent years within academia: more involvement in socio-economic development, greater emphasis on exploiting research results, correlated with: (1) an increase in patent and licensing activities, (2) the institutionalization of spin off activities and (3) managerial and attitudinal changes among academics with respect to collaborative projects with industry. These evolutions coincide with evolutions in terms of public funding mechanisms which stress societal relevancy and encourage collaboration between universities and industrial actors.<sup>1</sup> One might, therefore, speak of a ‘second academic revolution’ during the 1990s,<sup>2</sup> adding entrepreneurial objectives as a third component to the mission of the university (Cohen and Noll, 1994; Branscomb et al., 1999; Etzkowitz and Kemelgor, 1998; Etzkowitz and Leydesdorff, 2000).

## 2. Entrepreneurial universities: advantages and concerns

This renewed and increased interest in the phenomenon of the entrepreneurial university has resulted in the identification of advantages as well as concerns. Advantages can be identified in terms of improving industrial innovation, additional university funding opportunities or, indeed, the faster exploitation of new inventions by increased patenting or spin-off activity. At the same time, the increasing trend of developing entrepreneurial capabilities in academia gave rise to several concerns related to the role of academia within society (Gibbons, 1999; Kelch, 2002; Martin, 2001, 2002). Indeed, an explicit fear is related to the impact of university–industry cooperation on the research agendas of university researchers (Geuna, 1999; Hane, 1999; Vavakova, 1998) and the conflicts of commitment and

interest (Faria, 2002) that occur when faculty members’ full-time duties (teaching, research, time with students and service obligations to the university) are affected by activities stemming from involvement in company cooperation such as consulting activities, notwithstanding the observation that most universities have formal policies regarding and regulating this issue<sup>3</sup> (ACE, 2001). The major concerns derive from the fundamentally different reward and incentive systems of academic and private sector research, in terms of (1) the relationship between disclosure versus secrecy and (2) the complementarities and substitution effects between public and private R&D expenditures (Dasgupta and David, 1987, 1994).

In terms of incentive systems, one of the cornerstones of the academic enterprise concerns the publication of research results and the opportunity for open discussions among colleagues. Companies, on the other hand, have a responsibility for and a need to protect the value of their investments. These differences in the incentive systems of public and private research create challenges with regard to the dissemination of information, the nature of the research conducted and the access to research results (Hane, 1999; Murray and Stern, 2004; Tijssen, 2004) and are, therefore, re-opening debates on the norms and values that guide academic science (see for instance, Merton, 1968a,b; Mitroff, 1974; Mulkay, 1976). For example, some forms of publication might be delayed or suppressed because firms may ask universities to keep information (temporarily) confidential. This might reduce the incentive to publish and run counter to the academic norm of open dissemination of scientific knowledge (Blumenthal et al., 1996). Florida and Cohen (1999) referred to this as the ‘secrecy problem’ in research universities. Empirical evidence has, indeed, shown an association between industry support for research and restrictions regarding the disclosure of the research performed. Blumenthal et al. (1996) surveyed life science faculties and companies supporting these faculties. They found evidence for the fact that delaying publications and restricting information sharing are quite common, for instance, to allow sufficient time for the sponsoring company to file a patent application, to protect the financial value of certain research results, or to avoid undermining the competitive status of the sponsoring company. Brooks and Randazzese (1999) cite other empirical evidence of the ‘secrecy problem’ but also point to a possible effect of the research institute characteristics in the sense that the best research

<sup>1</sup> As can be witnessed for instance in the different EU Framework programs.

<sup>2</sup> After research complemented education as an inherent part of university’s mission during the 19th century, the so-called ‘first academic revolution’.

<sup>3</sup> See in this respect, for instance, policies at MIT restricting faculty members from undertaking research with spin-off companies.

universities seem quite capable of protecting their traditional values of openness and seem to make only modest concessions to the practical needs of industry.

Besides the ‘secrecy problem’, it can be noted that both individual researchers and research institutions can develop financial interests in the specific research outcomes, leading to a possible bias towards certain fields and activities (ACE, 2001). This phenomenon brings us to one of the main concerns of the opponents of intensifying collaborations between universities and industries, namely that the academic research agenda will be ‘contaminated’ by the application-oriented needs of industrial corporations—the ‘corporate manipulation thesis’ (Noble, 1977). From this perspective, university research is seen as characterized by an independence that should allow academics to freely contribute to theories and models at the endless frontier of science, in a (purely) curiosity-driven approach. The corporate manipulation thesis argues that corporations interfere with the normal pursuit of science and that they seek to control relevant university research for their own ends, rather than allowing faculty members to advance their research agenda through the pursuit of opportunities for federal and industrial funding.<sup>4</sup> The changes in the university research agenda are most often related to an alleged shift towards the more applied research end, referred to as the ‘skewing problem’ (Florida and Cohen, 1999).

The empirical evidence on both problems appears to be rather scarce and of a mixed nature. Surveys by Rahm (in Florida and Cohen, 1999) and Morgan (in Florida and Cohen, 1999) found some empirical association between greater faculty involvement in industry and increased levels of applied research. Research centers that value the mission of improving industrial products and processes devote less of their R&D activities to basic research than centers that do not value this industry-oriented mission.<sup>5</sup> Additional evidence in this respect has been reported for Norwegian university faculties (Gulbrandsen and Smeby, in Geuna and Nesta, 2003). Here, it was found that faculties with industry funding undertook significantly less basic research than researchers with no such external funds. In the same research setting, approxi-

mately 20% of the researchers reported contract research to be problematic for the autonomy and independence of their research. In this respect, it can be noted that certain research centers have made collaboration with industry – or involvement in business networks – an explicit part of their mission. Likewise, certain funding mechanisms also favor cooperation between industry and university, in the US, Japan and Europe (Florida and Cohen, 1999). Hence, the direction of this relationship remains to be resolved. On the one hand, it may be that researchers adjust their agendas in response to an increased cooperation with industry. On the other hand, industrial partners might, nonetheless, turn to research centers with an application-oriented agenda rather than to centers known for performing basic research. In the latter case, the observed effect is only a selection effect.

At the same time, several studies react to the opponents of industry involvement on the grounds of an alleged skewing of the research agenda. Those studies show that performing more applied research does not necessarily imply a trade-off with basic research. For instance, data from the US National Science Board have shown that in the 1980s, although the number of university–industry research centers almost doubled, the overall share of university research, classified as basic research, remained quite stable. Hicks and Hamilton (1999) found that the percentage of basic research that was performed at universities remained unchanged between 1981 and 1995, a period during which, at the same time, a sharp increase in university patenting could be observed. They also reported that the number of citations for university–industry papers was higher than for single university papers, which suggests that university researchers may be able to enhance their scientific impact by collaborating with industry partners. Godin and Gingras (2000), when analyzing publication data from Canadian researchers over a 15-year period (1980–1995), conclude that: “beliefs that collaborative research (with industry) is detrimental to academic research do not seem to be empirically grounded”. Similar observations are advanced by Brooks and Randazzese (1999) within the US semiconductor industry, where a consortium of semiconductor producers (SRC) funded university semiconductor research. No indication was found that the SRC support led academics to conduct less ‘foundational’ research (Brooks and Randazzese, 1999). Recently, Owen-Smith (2003) highlighted the changed relationships between commercial and academic systems. Whereas these used to be separate systems, Owen-Smith’s findings suggest that commercial and academic standards for success have now become integrated into what is called a hybrid regime, where

<sup>4</sup> For a recent overview on this debate within the field of Medicine, see Kelch (2002); with respect to policies adopted in order to address potential conflicts of interest within this field, see Drazen and Curfman (2002).

<sup>5</sup> Centers that see improving industrial products and processes as part of their mission spend about 19% of their R&D activities on basic research, while university centers that do not consider this important devote about 61% of their R&D activities to basic research (Florida and Cohen, 1999).

achievement in one realm is dependent upon success in the other. This observation has been confirmed by previous research in which the relationship between scientific performance and engagement in contract research with industry was examined more systematically (Ranga et al., 2003; Van Looy et al., 2004). The findings revealed that contract research and scientific activities do not hamper each other: systematic engagement in contract research coincided with increased publication outputs, without affecting the nature of the publications involved. As resources increased, the positive relation between both types of activities became more pronounced, pointing to a Matthew effect.

Contract research, however, represents only one type of entrepreneurial activity occurring at universities. In the case of inventions, the potential conflict between public- and private-oriented considerations in terms of diffusion of knowledge (secrecy versus free dissemination) seems most salient. In that respect, analyzing publication outputs of academic inventors – and comparing them to those of non-inventors – can provide additional insights into whether an academic's entrepreneurial and scientific activities can be reconciled or whether they are of a more conflicting nature. Therefore, the number and the nature of publications produced by academic inventors will be the focus of this contribution. By comparing publication profiles of academic inventors with those of academic staff working in similar fields but not engaged in patenting activities, the presence of the 'secrecy' phenomenon and the 'skewing' phenomenon can both be assessed. Whereas differences in terms of number of publications provide an indication of the trade-offs between publishing within the scientific forum versus involvement in patentable technology development, differences in terms of the nature of publications – basic versus applied – can provide (counter-)evidence for the presence of 'skewing' or 'contamination' processes. Finally, given the findings reported by Van Looy et al. (2004) – which pointed to a positive relationship between involvement in contract research and publication output – involvement in contract research will be taken into account as a moderating variable. The following research questions are central to the empirical study:

- Do faculty members engaged in patenting activity (inventors) publish less than their colleagues in comparable research areas who are not engaged in such invention activities?
- Do inventors differ from colleagues (non-inventors) in terms of the nature of their publications? And if so, to what extent does this difference coincide with a shift towards more application-oriented publications?

- To what extent does involvement in contract research with industry influence the co-existence of patenting and publication activities? Stated otherwise, to what extent do both types of entrepreneurial activity – i.e. contract research and patenting – coincide with different publication patterns, both in terms of volume and nature (basic/applied)?

### 3. Empirical analysis

In this paper, we try to understand whether it is feasible to balance scientific and entrepreneurial activities by empirically examining the experiences of researchers at a particular university, namely the Catholic University of Leuven (K.U. Leuven), Belgium. Firstly, we provide some background information on the approach followed at K.U. Leuven as to the transfer of knowledge and technology. We will then examine more closely the publication behavior of inventors, i.e. academic staff actively patenting the results of their research endeavors, in comparison to the publication behavior of their peers working in similar fields. A comparison of publication activity will then allow us to address the central research questions raised in the previous section.

#### 3.1. *Situating the data: the Catholic University of Leuven, Belgium*

Founded in 1425, the Catholic University of Leuven is one of the oldest universities in Europe and has approximately 30,000 students and 14 faculties, including not only engineering and medicine but also numerous and various disciplines in the social sciences, the arts and the humanities. From the 1970s and 1980s onwards, K.U. Leuven has adopted a strategic stance towards knowledge transfer and participation in regional and (inter)national economic development. In order to create a supportive context in this respect, the University of Leuven founded K.U. Leuven Research and Development (LRD) in 1972, primarily oriented towards stimulating and supporting knowledge and technology transfer between academia and industry. To this end, LRD offers advice as well as coordinative, administrative and legal support to its faculty members.

Three major activity poles can be discerned when looking at the activities of LRD. The first one involves an active patenting and licensing policy, implemented through the creation of an internal patent office and the establishment of a patent fund to help research groups cover the initial costs related to their patenting needs. A second activity pole is the creation of spin-off companies. It implies the development and deployment of the

necessary mechanisms and processes to assist in business plan development and raising venture capital. In order to achieve the latter, the university has created its own seed funds and growth fund in partnership with two major Belgian banks. Finally, the oldest and still the most important activity pole of LRD is the administration of contract research, providing almost 25% of the university's R&D budget.

LRD has developed the necessary processes for financial and personnel management to support these activities, and it provides the legal and intellectual property mechanisms to underpin these activities (Debackere, 2000). In terms of incentive systems, a dual approach has been adopted for members of LRD divisions. On the one hand, the striving for scientific excellence is rewarded through the hierarchical structures of the faculties and their departments. Excellence in entrepreneurship and industrial innovation, on the other hand, is rewarded through the LRD structure which offers financial autonomy and budgetary flexibility to the research divisions, allowing them to share in the possible benefits from their innovative and entrepreneurial activities. As far as patent policy is concerned, K.U. Leuven R&D applies strict rules to protect researchers' freedom to publish—a freedom which is always guaranteed. As a consequence, there can be a delay of a maximum of 3 months before releasing a paper for publication in order to allow the required patent procedures to be executed. In the majority of the cases, the publication delays experienced are less than 2 weeks.

The question, however, remains as to whether this balance between scientific ambitions on the one hand and entrepreneurial activities on the other hand is actually being achieved. In other words, does the dual incentive structure for researchers at the university actually stimulate a balance between scientific and exploitation/entrepreneurial activities, or do both activities interfere or even jeopardize one another, resulting in a de facto task division?

In order to obtain insights into this issue, we performed a detailed analysis of the publication performance and profiles of faculty members who are registered as inventors of EPO patents with application years between 1995 and 2001. We compared their scientific profiles to those of their colleagues working in similar fields but who are not registered as inventors.

### 3.2. Results

In a first step, all inventors – who are faculty members at K.U. Leuven – have been identified for the period 1995–2001. Inventors are defined as (a) appearing in

Table 1  
Total number of inventors by discipline

Discipline	Number of inventors
Medicine & Pharmaceuticals	20
Applied Engineering	5
Science	3
Agriculture	4
Total	32

the inventor name fields of granted EPO patents during the period 1995–2001 and (2) being employed by K.U. Leuven as a member of the faculty (i.e. as a professor) at the time of the invention. Note that this definition does not necessarily imply that K.U. Leuven is acting as an assignee; in approximately half the cases, patents are held by companies within the framework of contract research agreements established with firms or obtained by firms subsequently (in this respect, see also Balconi et al., 2002; Saragossi and van Pottelsberghe, 2003). In total, 32 inventors – who are, at the same time, professors at K.U. Leuven – have been clearly identified. The total number of patents held by these inventors amounts to 70, with the number of patents held by individual inventors ranging from 1 to 8.

As shown in Table 1, the faculty of Medicine and Pharmaceuticals figures prominently in this sample (62.5%). This predominance can be related directly to the relative importance of patenting and licensing activities as a technology transfer mechanism for this discipline (while, for instance, contract research and spin-offs appear more frequently in the case of Applied Sciences).

For each inventor, the total number of scientific publications, as retrieved via the web of science (library license), was counted for the period 1998–2000. In a subsequent step, a matching group was formed consisting of faculty members not engaged in patent activity<sup>6</sup> ( $n = 2$ -to-3 for each professor-inventor) working as a professor within the same discipline or field and with a comparable career profile.<sup>7</sup> This approach – which allows for paired sample comparisons – is appropriate, given the field-specific nature of the Web-of-Science publication output classification systems, as borne out by previous research (Van Looy et al., 2004). In other words, we

<sup>6</sup> In order to verify the latter, all names of non-inventors have been verified in the INPADOC database, comprising patent data of 70 different patent systems.

<sup>7</sup> Both in terms of age, timing of different career steps (obtaining PhD – first appointment as professor) deviations of 3 years or less were allowed. In terms of full- or part-time occupation, the match had to be identical.



Table 2

Results of paired sample *t*-test for total numbers of (SCIE) publications inventors/non-inventors

	Mean difference	Std. deviation	Std. error mean	95% confidence interval of the difference		<i>t</i>	d.f.	Significance (2-tailed)
				Lower	Upper			
Complete sample	24.14	50.12	8.86	6.07	42.21	2.72	31	0.010
Sample without outliers	10.72	18.25	3.39	3.77	17.66	3.16	28	0.004

compared inventors and non-inventors who publish in the same disciplinary areas and, at the same time, are comparable in terms of discipline, age and career profile.

A straightforward paired sample *t*-test reveals that inventors publish significantly more than colleagues in similar fields and whose profiles have similar characteristics, both in terms of age and career progress and tenure ( $t = 2726$ , d.f. = 31;  $p = 0.01$ ). As illustrated in Table 2, the standard deviation is high, resulting from the presence within the sample of three *inventors* involved in more than 90 publications (either as author or co-author) during the period considered in our analysis. These inventors/authors could be clearly labeled as ‘star scientists’ in our sample. While it is interesting to note that such star scientists are also inventors, it needs to be verified whether the observed significant effect is mainly caused by the presence of these star scientists (outliers in terms of publication output). Hence, in a subsequent step, these outliers were removed from the analysis. As is obvious from Table 2, the previous findings are confirmed at an even higher level of significance due to the reduction in variation.

These initial observations seem to indicate that academic inventors publish more than similar colleagues not involved in patenting activity. At the same time, it can be noted that such a cross-sectional analysis does not reveal any indications on the patterns of causality implied. In order to scrutinize such patterns, additional time series data have been created for a sample of inventors. For a random selection of inventor-control pairs, publication output was mapped over time ( $n = 16$ ). In these time series, we introduced the priority year of the inventor’s first patent. Fig. 1 illustrates the data obtained for a number of inventors.

As Fig. 1 demonstrates, a multitude of patterns can be discerned. Firstly, there are cases in which inventors perform better than their counterparts – who were never inventors – in the period before patenting activity was observed. After the first patent was filed, the difference in publication output increases in favor of inventors (Sciences, Inventor 1; Medicine, Inventor 1). Secondly, one observes patterns where the amount of publication out-

put between inventors and non-inventors is more or less similar prior to invention, while considerable differences appear afterwards, again in favor of inventors (Sciences, Inventor 2; Applied Sciences, Inventor 1). Thirdly, one occasionally observes the reverse pattern where inventors are clearly being outperformed by non-inventors, in the period before and after patenting (Applied Science, Inventor 2). Finally, one notices, in some cases, similar patterns in terms of publication volume over time, before and after patenting (Medicine, Inventor 2).

In order to create a systematic view of the overall effects of the different dynamics at play, we analyzed these longitudinal data by defining a before and after invention variable. This variable takes on the value of 0/1 depending on whether the publication data for the inventors and their counterparts are located in a period before or after patenting activity took place. In addition, an inventor variable was included in order to account for idiosyncrasies in the patterns described. Table 3 provides an overview of the findings obtained when conducting an ANOVA with the difference between inventors and their respective control group in terms of number of publications (per year) acting as a dependent variable.

In line with the previous findings, inventors differ significantly in terms of publication output. As Table 4 clarifies, on average, inventors publish 3.62 more papers per year than the control group. At the same time, one observes a significant main effect of the period, i.e. before or after patenting. While before patenting, the average difference amounts to 2.33 publications per year, this difference increases to 4.58 after patenting. This observation confirms the presence of the ‘high flier’ or ‘star scientist’ phenomenon, i.e. academic inventors are among the better performing scientists. At the same time, these findings also strongly suggest a leverage effect of patent activity on publication output. Finally, the significant interaction effect between inventors and period (before/after) reminds us of the idiosyncratic nature of the underlying dynamics. Whilst, on average, inventors do indeed publish more – and even more after inventing – this does not hold true for all inventors, as Fig. 1 demonstrates.

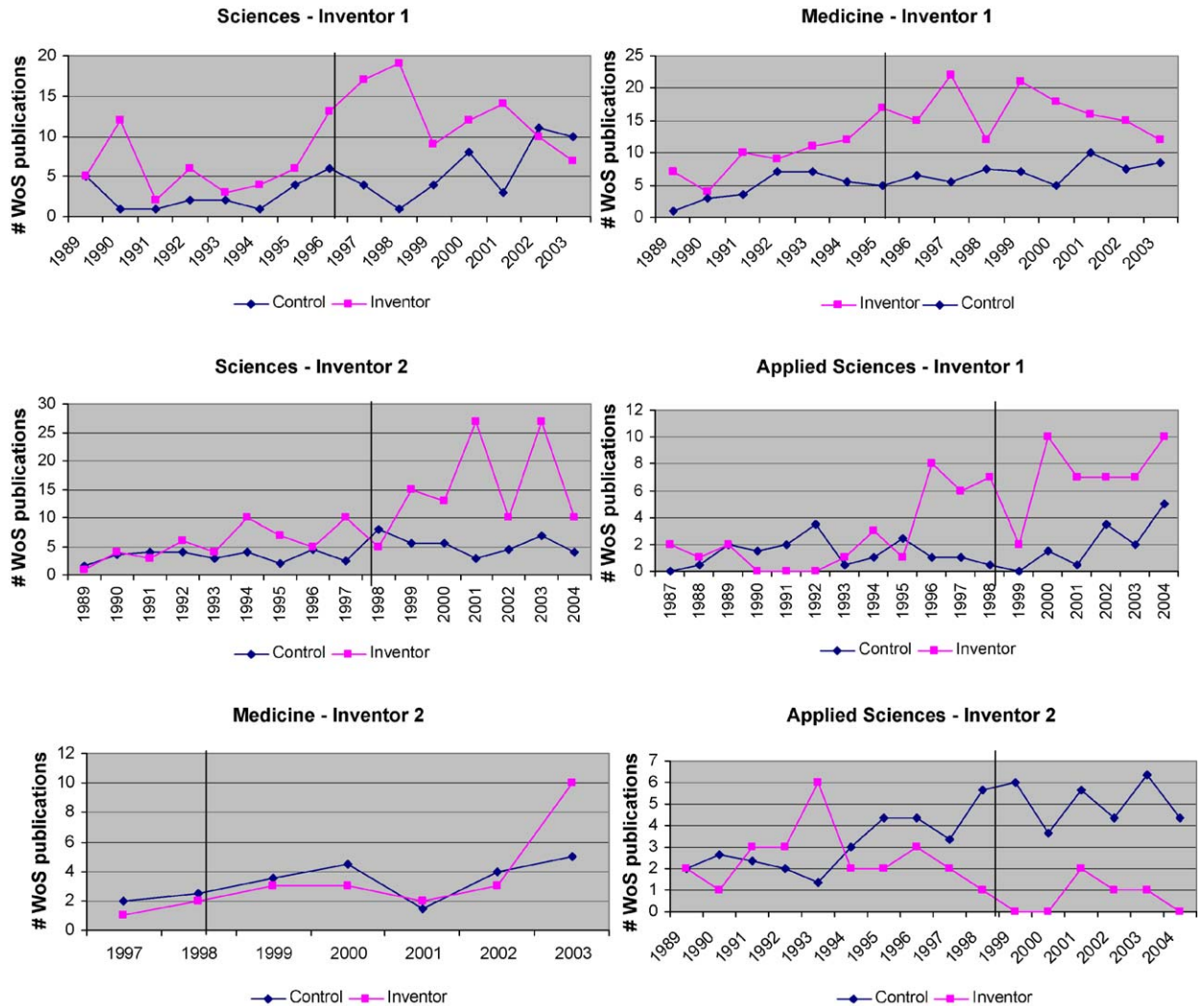


Fig. 1. Time series data publication amount inventors and control persons (vertical lines representing priority year of inventor's first patent).

### 3.2.1. Nature of publications

Our second research question relates to the nature of the publications. Are inventors' publications of a different (e.g. more applied) nature than those of colleagues

(non-inventors) working in similar fields? In order to answer this question, the publications identified had to be characterized in greater depth. The nature of a publication is assessed according to the categorization

Table 3

ANOVA results: difference in terms of publication output (year) between inventors and controls acting as dependent variable

Source	Type III sum of squares	d.f.	Mean square	F	Significance
Corrected model	4994.264 <sup>a</sup>	25	199.771	7.686	0.000
Intercept	1874.024	1	1874.024	72.100	0.000
Before/after (0/1)	384.875	1	384.875	14.807	0.000
Inventor	3104.285	12	258.690	9.953	0.000
Before/after × inventor	1228.103	12	102.342	3.937	0.000
Error	4496.643	173	25.992		
Total	12098.103	199			
Corrected total	9490.907	198			

<sup>a</sup>  $R^2 = 0.526$  (adjusted  $R^2 = 0.458$ ).

Table 4  
Mean difference in publication output (per year) between inventors and controls (for longitudinal sample)

	Mean	Std. deviation	N	Significance
Before invention	2.33	4.80	85	0.000
After invention	4.58	8.04	114	0.000
Total	3.62	6.92	199	0.000

Table 5  
Classification of nature of publications

Technology-oriented		
Applied	Type 1	Applied technology
Basic	Type 2	Engineering science–Technological science
Science-oriented		
Applied	Type 3	Applied research–Targeted basic research
Basic	Type 4	Basic scientific research

developed by Godin (1996). Each publication (journals or even journal issues) covered by the SCIE is classified into one of four categories that range from ‘applied technology’ to ‘basic scientific’. As a first step, the publications are categorized as either ‘technology-oriented’ or ‘science-oriented’. Then, a basic and applied orientation is distinguished, resulting in the four-class categorization summarized in Table 5 (see Godin, 1996).

Firstly, the relationship between the nature of the publications and the presence or absence of ‘inventorship’ was examined for the total group by means of a  $\chi$ -square test.<sup>8</sup> Table 6 reports the observed and expected frequency values as well as the level of significance attained. We observe a highly significant relationship between both variables ( $p < 0.0001$ ). In other words, inventors publish considerably *less* than expected in technology-oriented journals (142 observed versus 207 expected publications). Inventors, though, publish more in science-oriented journals, the difference between observed and expected values being most pronounced for category 3 (‘Science-oriented – Applied’ type of publications).

Secondly, similar analyses have been conducted for each discipline separately. The findings, reported in Table 7, are in line with the results obtained for the total group: inventors publish relatively more in science-

oriented journals. At the same time, discipline differences become apparent. For Medicine and Pharmaceuticals as well as Agriculture, category 3 is more prevalent among inventors while, for Sciences, category 4 is prevalent. For Applied Engineering, a different picture emerges: inventors publish relatively more in technology-oriented journals of a more basic-oriented nature (category 2), and less in category 3 type journals.

Overall, our findings do not allow us to support the idea that involvement in technology development (as an inventor) implies a systematic shift towards publications of a more applied nature. For three of the four disciplines examined in this paper, inventors published relatively more within the more science-oriented journals. For the one discipline that did not reflect this pattern – Applied Engineering – a relative predominance of technology-oriented publications of a more *basic* nature was observed, contradicting again what one might have expected, based on some of the concerns raised in the literature on the ‘skewing problem’.

### 3.2.2. Inventors, publications and involvement in contract research

In previous research, the impact of the involvement of faculty members in contract research on publication output (both in terms of type and volume of output) has been analyzed. A positive relationship between volume of scientific publications – measured in a similar manner, i.e. publication output covered by the SCIE Index – and involvement in contract research became apparent (Van Looy et al., 2004). One of the elements identified to explain this positive relationship was the presence of research divisions.<sup>9</sup> These divisions were established at K.U. Leuven as an important transfer mechanism and were created by, at least, three faculty members as a means to jointly expand their research activities. The size of those research divisions ranges from as few as 4 or 5 staff members to research groups consisting of 60 or more members. Given the positive relationship that was found between the differences in publication output of professors involved in divisional activities (compared to colleagues working in similar fields but not being members of divisional structures) and the size of the research divisions, the next logical step is to extend the analysis to include divisional membership as an explanatory variable. To this end, a more extended matching sample was

<sup>8</sup> As we have created two control groups – one implying membership of a research division involved in exploitation of research, one excluding membership of such divisions –, the ‘non-inventors’ group is larger than the group of inventors, resulting in a higher number of total publications, despite average numbers which are clearly lower as was apparent in the previous section.

<sup>9</sup> K.U. Leuven R&D, the technology transfer division of K.U. Leuven, provides a legal and administrative framework for these research groups – that are fully integrated within K.U. Leuven – while the members of the division themselves are responsible for acquiring the funds deemed relevant for pursuing their activities.



Table 6  
Relationship between nature of publications and involvement in inventions

	Nature of publications				Total
	Technology-oriented		Science-oriented		
	Applied	Basic	Applied	Basic	
Observed					
Inventors	23	119	257	188	587
Non-inventors	79	221	186	181	667
Total	102	340	443	369	1254
Expected					
Inventors	47.75	159.15	207.37	172.73	587
Non-Inventors	54.25	180.85	235.63	196.27	667
Total	102	340	443	369	1254
Significance	$p < 0.0001$				

created; this time including ‘similar’ colleagues participating both in division activities and ‘similar’ colleagues not participating in division activities.<sup>10</sup> Table 8 summarizes the findings of an ANCOVA performed on the total number of publications as the dependent variable, with inventorship (Y/N), divisional membership (Y/N) and discipline (see Table 1) as independent factors, and age as a covariate.

As is apparent from Table 8, inventorship, division membership and discipline have significant main effects. For the inventorship independent variable, this main effect is positive in terms of publication volume (see Table 2). The same applies to division membership ( $t = 2.42$ ,  $p = 0.019$ ). At the same time, the interaction effect ‘division membership  $\times$  inventor’ is significant. Inventors who are also division members ‘outperform’ their colleagues who are inventors but not division members, as well as colleagues who are working within a research division without being inventors. These findings are in line with the positive effect of division membership on publication output as reported by Van Looy et al. (2004). They also point to the resource dependency of modern academic research activities: being a division member provides the researcher with greater access to both scientific and financial resources because of the scale and scope effects that occur when several researchers pool their activities. Finally, we observe an interaction effect between discipline and division mem-

bership. Whereas publication outputs vary significantly with discipline – Agriculture and Sciences showing the highest numbers followed by Medicine and Applied Engineering – the positive impact of division membership is more pronounced in the case of Agriculture and Applied Science.

Overall, the findings obtained are straightforward: inventors systematically publish more than their colleagues who are not engaged in patenting activities but who are working in similar fields and who have comparable age and career profiles. In addition, involvement in research division activities further adds to the differential publication output.

#### 4. Discussion

The evolving role and position of universities in the broader context of national and regional innovation systems has led to concerns about the feasibility of combining educational, scientific and entrepreneurial activities within universities. In this analysis, we have examined the relationship between scientific inquiry and science exploitation, where the amount and the nature of the publication output was the focus of analysis. Publication output from K.U. Leuven faculty members who were concurrently involved in patenting work as inventors was compared to the publication output of scholars working in similar disciplines and with comparable career profiles but with no involvement in patenting activities. This analysis led to the following major observations. Firstly, inventors publish significantly more than their colleagues who work in similar fields and who have similar career characteristics; this holds true when we take into account other variables (discipline, division mem-

<sup>10</sup> In theory, this would lead to a total sample of 96 observations; unfortunately, it was not possible to create two complete matching groups for all inventors (e.g. all colleagues with a similar profile being either involved or not involved in division activities), resulting in an overall sample which is slightly smaller ( $n = 82$ ).

Table 7  
Relationship between nature of publications and involvement in inventions—breakdown by discipline

	Nature of publications				
	Technology-oriented		Science-oriented		Total
	Applied	Basic	Applied	Basic	
Medicine & pharmaceuticals					
Observed					
Inventors	12	57	179	78	326
Non-Inventors	60	127	83	112	382
Expected					
Inventors	33.15	84.72	120.64	87.49	326
Non-inventors	38.85	99.28	141.36	102.51	382
Significance	$p < 0.0001$				
Agriculture					
Observed					
Inventors	0	9	53	59	121
Non-Inventors	7	64	26	29	126
Expected					
Inventors	3.43	35.76	38.70	43.11	121
Non-inventors	3.57	37.24	40.30	44.89	126
Significance	$p < 0.0001$				
Applied Engineering					
Observed					
Inventors	11	49	16	2	78
Non-Inventors	11	27	37	2	77
Expected					
Inventors	11.07	38.25	26.67	2.01	78
Non-inventors	10.93	37.75	26.33	1.99	77
Significance	$p < 0.0025$				
Science					
Observed					
Inventors	0	4	9	49	62
Non-inventors	1	3	40	38	82
Expected					
Inventors	0.43	3.01	21.10	37.46	62
Non-inventors	0.57	3.99	27.90	49.54	82
Significance	$p < 0.0001$				

bership) that might moderate the amount of their scientific output. When disentangling this difference in terms of publication over time, two phenomena are apparent. Indeed, inventors tend to publish more than non-inventors, even years before the first inventive, patenting activity is observed. As such, this observation suggests the presence of the ‘star scientist’ phenomenon. At the same time, it is apparent that involvement in patenting activities increases the publication difference in favor of inventors. As a consequence, involvement in inventive activities does not seem to hamper ‘pure’ scientific

activities, at least not in terms of publication amount. Rather, our data suggest a reinforcing or positive spillover effect on scientific performance from engaging in technology development efforts.

When taking into account the nature of the publications analyzed, it emerges that, in general, inventors publish more in scientifically oriented journals than their colleagues who are not involved in patenting. The exception is in Applied Engineering. Here, inventors publish more in technology-oriented journals of a *basic* nature. Hence, the results from our data analysis do not con-

Table 8  
ANCOVA results: total number of (SCIE) publications acting as dependent variable

Source	Type III sum of squares	d.f.	Mean square	<i>F</i>	Significance
Corrected Model	8084.403 <sup>a</sup>	16	505.275	5.325	0.000
Intercept	229.633	1	229.633	2.420	0.125
Age (covariate)	57.804	1	57.804	0.609	0.438
Division membership (DIV)	2930.278	1	2930.278	30.881	0.000
Discipline (DIS)	2482.647	3	827.549	8.721	0.000
Inventor (INV)	1731.204	1	1731.204	18.244	0.000
DIV × DISC	1616.784	3	538.928	5.680	0.002
DIV × INV	1070.976	1	1070.976	11.287	0.001
DISC × INV	458.711	3	152.904	1.611	0.195
DIV × DISC × INV	511.256	3	170.419	1.796	0.157
Error	6167.821	65	94.890		
Total	34806.213	82			
Corrected total	14252.224	81			

<sup>a</sup>  $R^2 = 0.567$  (adjusted  $R^2 = 0.461$ ).

firm the presence of a skewing problem in terms of an alleged shift of publication output towards the more technological or applied end of the publication spectrum *at the expense* of more scientific or basic-oriented publications. Rather, our findings support Owen-Smith's (2003) 'hybrid regime' view of commercial and academic activities, where achievement in one realm is in part dependent on success in the other. Actually, both publication and patenting activities are not very different in terms of their intellectual challenge and nature. In both instances, creativity, originality and novelty are key contributing factors to effectiveness. Indeed, during the preparatory work conducted for this research, a number of inventors expressed the belief that they had improved the quality and the state-of-the-art character of their fundamental research questions as a result of the insights they had obtained from a detailed scrutiny and awareness of the patent literature. In other words, involvement in both realms of activity may produce mutually beneficial spill-over effects, which affect scientific performance as well—at least where research topics in both activity realms are closely related (Carayol, 2003).

Based on present findings, we tend to conclude that it is feasible to organize both scientific and entrepreneurial activities, without one jeopardizing the other. Debackere (2000) pointed to the importance of appropriate strategies, organizational structure and management processes in achieving this end. The research division approach, juxtaposed with the Faculty structure, has created a de facto matrix structure. Crucial in terms of the effective functioning of this structure is the presence of incentive arrangements of a dual nature, in which research excellence prevails along the hierarchical lines of the faculties and their departments, and excellence in entrepreneurial

innovation is rewarded along the lines of the LRD divisions.

These findings also point to several interesting and challenging avenues for further research. First of all, our study needs to be complemented with research efforts aimed at 'external' validation—using the same fine-grained data type employed in this analysis but extrapolating beyond the boundaries of K.U. Leuven. Specific points for attention relate to latent, unintended or unwanted consequences of the phenomena observed and the precise nature of (institutional) arrangements fostering the co-existence of multiple objectives and, hence, the achievement of both scientific and entrepreneurial excellence. Such endeavors hold out the prospect of enhancing our understanding of the impact that institutional arrangements and incentive structures may have on feasibly combining both types of activity in an academic context—in short, their potential for helping or hindering the process. In future research, it might also prove worthwhile to include the impact of the publication output (in terms of citations) and the involvement of researchers in educational activities.

In conclusion, we must stress the limitations of the findings presented in this article. It is clear that many tensions and problems arise in the current transformation taking place across the university landscape. As outlined by Nelson (2004), this transformation raises important questions concerning the openness of the scientific 'enterprise'. While our findings reveal that reconciliation between different activity realms appears feasible in this particular university at the level of *individual faculty*, increasing our understanding of how such positive effects unfold – and under what conditions – is an issue that should remain high on our research agendas.

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